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1362789

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(19)

(54) TREATMENT OF LIQUIDS

(71) We, THE BRITISH OXYGEN COMPANY LIMITED, an English company, of Hammersmith House, London W6 9DX, England, do hereby declare the invention,

for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the treatment of a liquid, and in particular to treating with gas a liquid foodstuff, contaminated water, industrial effluent or sewage. Such treatment is becoming increasingly important in improving purity of water for human consumption and use. In prior proposals in which it was required to entrain a gas in a liquid it has been know to inject the gas directly into a tank containing the liquid. This is disadvantageous as an agitator for the liquid and a fan or compressor for the gas is generally required to effect sufficient entrainment of the gas in the liquid.

According to the present invention there is provided apparatus for treating liquid with gas, including a liquid conduct, a gas conduit which extends axially through the liquid conduit and which terminates in a distributor having perforations through which gas is able to pass into liquid flowing through the liquid conduit, wherein the gas conduit has a widened portion adjacent to the distributor, which widened portion forms a constriction in the liquid conduit adapted to create turbulent liquid flow downstream of the distributor.

A particularly convenient form of perforated distributor is of gauze.

The distributor is preferably shaped so that it provides little impediment to the liquid flow. Accordingly, the distributor preferably has the shape of a cone, pyramid or wedge and tapers inwards in the direction of liquid flow.

The dimensions of the apparatus according to the present invention may be chosen in accordance with the volume of liquid required to be treated at a given time. It may be convenient for treatment of large volumes of liquid to use more than one set of apparatus.

The widened portion of the gas conduit is preferably formed so that it causes only a small pressure drop while providing a high degree of turbulence downstream of the region where the gas is introduced. The preferred size of constriction depends on the rate of liquid flow and, if a pump is used to create a liquid flow, the characteristics of the pump. For example, the gas conduit can be coaxial with the liquid conduit, both being of circular cross-section. In this form of apparatus the widened portion preferably has an axial length in the range 10 to 100% of the diameter of the liquid conduit and a diameter in the range 80 to 98% of the diameter of the liquid conduit.

It can, on the other hand, be convenient for the coaxial gas and liquid conduits to be of rectangular cross-section. In this form of apparatus the cross-sectional area of the gas conduit is preferably in the range 60 to 95% of the cross-sectional area of the liquid conduit. Moreover, one pair of opposite walls of the liquid conduit preferably also define a corresponding opposite pair of walls of the gas conduit.

The axial length of widened portion of the gas conduit is preferably 10 to 100% of the distance between the pair of opposite walls of the liquid conduit not being shared with the gas conduit.

Upstream of the widened portion, the gas conduit is preferably dimensioned so that it does not create a substantial impediment to the liquid flow. Thus, immediately upstream of the widened portion the gas conduit preferably tapers outwards in the direction of the flow of gas.

Whereas previous forms of gas-liquid contact apparatus have often required a fan or compressor to aid the passage of gas through the gas conduit preferred forms of apparatus according to this invention may generally be used without a fan or compressor. This is because the action of liquid flowing through

and passed the constriction formed by the widened portion of the gas conduit draws gas into the gas conduit. Moreover, the preferred forms of apparatus according to this invention keep pressure drops along the liquid and gas conduits to a minimum.

The apparatus according to this invention may be used to introduce a gas into a liquid in order to purge the liquid of oxygen. Such treatment may usefully be applied to a liquid foodstuff in which oxygen promotes harmful bacteriological activity, to a liquid which is passed through or stored in apparatus which is corroded by oxygen, for example sulphur dioxide may be introduced into a liquid foodstuff as a preservative, or chlorine into water in order to prevent bacteriological activity. The apparatus is particularly useful if the gas is required to react with impurities in the liquid. For example it may be used in the treatment of impure water for example in treating industrial or domestic water supplies, effluent from industrial plant, or sewage. Oxygen or air may be used in this treatment, but more beneficial results may be achieved by using an oxygen-ozone or an air-ozone mixture. Accordingly the invention also provides a process for treating a liquid with a gas using the apparatus of the invention. The liquid treated can be a liquid foodstuff, industrial or dometstic water supplies, effluent from industrial plant or sewage.

The invention is now described by way of example with reference to the accompanying drawings, of which:

Figure 1 is a diagrammatic view of one form of apparatus for treating liquid with a gas:

Figure 2 shows a portion of the apparatus shown in Figure 1;

With reference to Figures 1 and 2, a pipe 2 leads to a pump 6 from a tank floor which contains liquid. By opening a valve 8 located in a pipe 2 and operating the pump 6 the liquid is passed from the tank 4 through a pipe 10 into a conduit 12 which is disposed vertically and leads to beneath the surface of the liquid at a region near the base of the tank 4. With a valve 24 open, gas is drawn into a conduit 14 located coaxially within the conduit 12. In its passage through the conduit 14, the gas flows through a widened outlet portion, comprising a portion 16 tapering in an upstream direction followed by a cylindrical portion 18, and then into a perforated distributor cone 20 formed from 48-mesh gauze. The portions 16 and 18 form a constriction to the flow of water through the conduit 12, and thereby induce a turbulent liquid flow in tre region where the distributor 20 is located. Gas flows from the distributor 20 into the turbulent liquid in a plurality of streams, and an intimate mixture of gas and liquid is formed downstream of the distributor and flows through the remaining section of the conduit 12 into the tank 4. The length of the conduit 12 downstream of the distributor 20 is sufficient to ensure that the gas is thoroughly entrained in the liquid before the liquid enters the tank 4.

Three sets of apparatus, of the type shown in Figure 1 and 2, but each having different dimensions, were tested using air as the gas and water as the liquid. The respective dimensions of each set are shown in Table 1.

TABLE 1

	Set 1	Set 2	Set 3
Diameter of Conduit 12	1.24 in	0.24 in	1.24 in
Diameter of Conduit 14	0.59 in	0.59 in	0.59 in
Diameter of cylindrical portion 18	1.13 in	1.13 in	1.19 in
Width of annular gap between the cylindrical portion 18 and the outlet section 12	0.055 in	0.055 in	0.025 in
Length of tapering portion 16	1.00 in	1.75 in	1.75 in
Length of distributor 20	4.00 in.	4.00 in	4.00 in

It can be seen that Set 1 includes a longer cylindrical portion 18 and a smaller tapering portion 16 than Set 2 and 3, and Set 3 has a wider cylindrical portion 18 than Set 2.

The rate at which air was drawn into the conduit 14 was compared with the rate of flow of water through the section 12 of the conduit 10. For each set of apparatus was found that the faster the rate at which water passes through conduit 12, the greater was the rate of ingress of air into the conduit 14. It was found that the Set 3 apparatus produced the greater air flow rate for a given rate of flow water, but that the Set 2 apparatus was more efficient with regard to the amount of work required to operate the pump 6. Some illustrative results are shown in Table 2.

TABLE 2

	Air Flow Rate	Air Pressure Drop	Water Flow Rate	Water Pressure Drop	Hydraulic Horse Power
	1 min^{-1}	cm SWG	1 min^{-1}	cm SWG	
Set 1	1.0	4.0	11.2		
	3.5	0.8	16.7		
	3.5	9.8	20.3		
	6.5	2.0	20.3		
Set 2	12.5	20.0	50.2	200	0.0219
	8.0	20.0	44.0		
	4.0	20.0	32.3		
	10.0	10.0	40.4		
	8.0	10.0	40.4		
	6.0	10.0	35.2		
Set 3	12.5	20.0	34.0	475	0.0340
	8.0	20.0	29.0		
	4.0	20.0	23.0		
	10.0	10.0	32.0		
	8.0	10.0	30.2		
	6.0	10.0	26.4		

WHAT WE CLAIM IS:—

1. Apparatus for treating liquid with gas, including a liquid conduit, a gas conduit which extends axially through the liquid conduit and which terminates in a distributor having perforations through which gas is able to pass into the liquid flowing through the liquid conduit, wherein the gas conduit has a widened portion adjacent to the distributor, which widened portion forms a constriction in the liquid conduit adapted to create turbulent flow of liquid downstream of the distributor.

2. Apparatus as claimed in claim 1, wherein the distributor is of gauze.

3. Apparatus as claimed in claim 1 or claim 2, wherein the distributor has the shape of a cone, pyramid or wedge and tapers inwardly in the direction of the liquid flow.

4. Apparatus as claimed in any preceding claim, wherein immediately upstream of the widened portion the gas conduit tapers out-

wards in the direction of the flow of gas.

5. Apparatus as claimed in any preceding claim, wherein the gas conduit is co-axial with the liquid conduit and both conduits are of circular cross-section.

6. Apparatus as claimed in claim 5, wherein the widened portion has an axial length in the range 10—100% of the diameter of the liquid conduit, and a diameter in the range 80—98% of the diameter of the liquid conduit.

7. Apparatus as claimed in any one of claims 1 to 4, wherein the gas conduit is co-axial with the liquid conduit and both conduits are of rectangular cross-section.

8. Apparatus as claimed in claim 7, wherein the widened portion has a cross-sectional area in the range 60 to 95% of the cross-sectional area of the liquid conduit.

9. Apparatus as claimed in claim 7 or claim 8, wherein a pair of opposite walls of the liquid conduit also define a corresponding pair of opposite walls of the gas conduit.

10. Apparatus as claimed in claim 9, wherein the axial length of the widened portion of the gas conduit is 10 to 100% of the distance of the pair of walls of the liquid conduit not shared with the gas conduit.

11. Apparatus as claimed in claim 1, substantially as herein described with reference to, and as shown in, the accompanying drawings.

For the Applicants,
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1362789 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

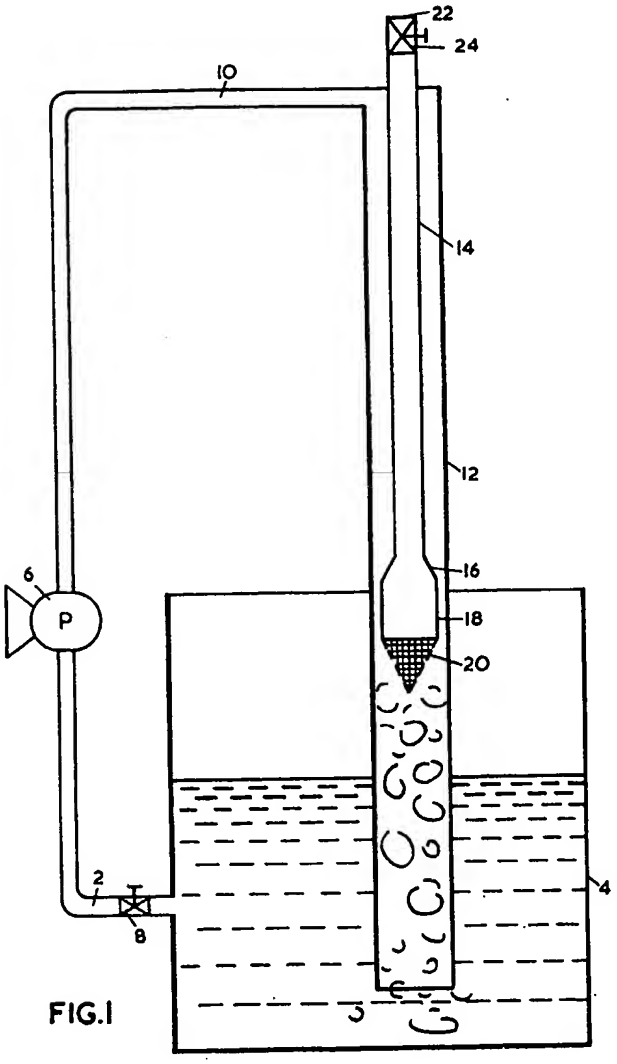

FIG.1

1362789 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

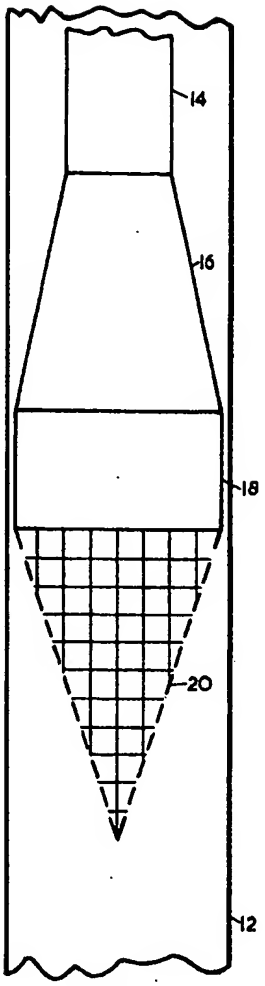

FIG. 2